PLOT MONITORING

SUBJECTS: English/Language Arts, Mathematics, Science, Health

GRADES: 4-8

DURATION: One class period

GROUP SIZE: one class of 25 - 30 students

SETTING: Outdoor classroom, open field, forest, or mixed landscape

KEY VOCABULARY: Plot, monitoring, fuel load, fuel model, fuel moisture,

ANTICIPATORY SET: Today you will learn to sample vegetation near your school. Using that information, you will predict the fire potential of the area around your school.

OBJECTIVES: Students will 1) understand correlation between fuel loads and fire potential; 2) be able to set up and obtain information from a monitoring plot ;

MATERIALS: One dowel rod, one tape measure, one ruler, and one clipboard for each pair of students; 2 stakes; 31 meters of cord (rope, string, or flagging tape); Plot Measurement worksheets; pencils; roll of newsprint or other long paper; red, yellow, blue and green marker pens.

BACKGROUND:
In nature, fires are an integral, cyclic part of a healthy forest. Depending (in part) on the type of debris (fallen branches, leaves, and other plant materials) that has accumulated in any given area this fire cycle may occur every 3-10 years, or may only occur once every hundred years or more. The ability of this debris to burn is directly related to the size and moisture level of the fuel. Smaller fuels ignite at a lower temperature, burn quickly, and are extinguished with less effort. Larger fuels require higher ignition temperatures, burn very slowly, and produce sufficient heat to dry out and ignite near-by fuels.

Under the right conditions, fuels can easily ignite when moisture levels reach 10% or less. Living fuels (growing plants, shrubs and trees) always contain at least 30% moisture levels. Dead woods and plants can contain as low as 0% moisture. Daily weather conditions will change the moisture content of dead fuels. The moisture content level of living plants is more likely to be affected by

insect damage and long-term or catastrophic weather conditions, such as drought, storms, or prolonged extremes of temperature. Heat from existing fires can dry living and dead fuels, reducing their moisture content to this 10% level. Once dry enough, the possibility of the fuel igniting is greatly increased.

A fuel is any material that will burn. Different types of materials burn at different temperatures. Natural fuels are catalogued into 13 various types, or models. Types 1,2, and 3 include grasses. Types 4, 5, 6, and 7 include shrubs. Types 8, 9, and 10 are timber litter. Types 11, 12, and 13 include logging slash. In general, the state of Kentucky is considered to have a fuel load of 8 or 9.

Fuel moisture is the amount of water in a fuel. It is expressed as a percentage of the oven-dry weight of that particular material. Fuel moisture levels can be categorized as light fuels or heavy fuels. Light fuels include leaves, grasses, and shrubs. Heavy fuels include limbs, logs, and stumps.

Fuels are affected by the temperature. As the temperature rises, heat from the sun dries out materials on the ground. If the air temperature is 90 degrees, the ground temperature can be 110 degrees! Fuels exposed to the sun will be hotter than the same fuels found in the shade. There can be as much as a 50-degree difference in temperature between areas exposed to the sun and those in the shade!

The moisture level within dead and dried vegetation can be affected by changing weather conditions. Fuels can thus be grouped, or catalogued, as one-hour, ten-hour, 100-hour or 1,000-hour fuels – the amount of time it takes to produce these changes. As the humidity level falls, moisture is pulled from available fuels by the surrounding dry air. These same fuels absorb moisture from the air when the humidity rises. Light fuels (one-hour fuels) are fuels with a stem diameter of 0"- ¼". All grasses are listed as one-hour fuels. These fuels are very susceptible to humidity changes. They can quickly dry out in low humidity or become more moist during a sudden rainstorm. Relative humidity levels, sun exposure and/or daytime temperature ranges can change the fire potential of this fuel in a very short time. Light fuels can change dramatically during a day in the sun.

Ten-hour fuels include ¼"-1" diameter sticks, twigs, and limbs. We expect these fuels to take approximately ten hours to change their fire potential by becoming either too moist to burn or dry enough to burn easily.

100-hour fuels are those that are 1"-3" in diameter. They and the 1000-hour fuels (diameter over 3") would be very slow to change. They include large branches, logs and living trees. Their moisture level changes very slowly over a longer period of time and they are not as affected by daily weather conditions. While heavy fuels are not affected by daily temperature changes, other factors such as insect damage, disease, and drought can weaken them. These conditions help to make the heavy fuels more susceptible to ignition.

As any of these fuels dry and approach a 10% moisture level, the potential for them to support a hot, fast fire increases.

Fires are also affected by fuel load. Fuel load is the quantity of fuel in a given area. A mowed lawn has a light fuel load and wouldn't be able to support a large fire. A forested area with lots of fallen trees, broken and dried limbs, and a thick carpet of dried leaves would have a heavy fuel load. A fire in this forest would be able to burn hot, have high flames, and last a long time.

The distribution of the fuels within an area will also influence fire behavior. Scattered fuels (i.e., a single stick laying on a sandy beach) won't be able to sustain a fire for very long. Fuels which touch and/or overlap (i.e., wood stacked for a campfire) are better able to provide a continuous burning.

Fire managers continuously monitor both the fuel load and the fuel moisture levels of their area. Fuel moisture levels are determined by the weather. Fuel loads are determined by local and seasonal growth rates. In this lesson, students will study fuels found near their school.

PROCEDURE:

Before the lesson begins:

1. Using a marker, draw lines on your cord at 30 centimeter intervals for a distance of 31 meters. There will be 103 points marked on a line 31 meters long. Each mark will be referred to as a "point intercept" (Pnt).

2. Choose an area for students to survey. Choose a "natural" or un-mowed area which contains any combination of grasses, flowers, shrubs, trees and/or fallen logs. Measure a distance of 30 meters in your chosen survey area.

3. Place a stake at each end of your area and tie the marked cord to each of the two stakes. Make the cord as taunt as possible. Be careful to not trample down the vegetation under the cord when setting up your survey line!

In the classroom:

4. The teacher should show the students a sample piece of marked cord, pointing out the "point intercept" marks. Caution the children that when they are in the field they should be careful not to trample the vegetation under or near the cord.

5. Go over the following directions while in the classroom:

- Pairs of students will work together. These two students should put their names on the "Plot Measurement Worksheet". Each pair of students will survey 3-4 points of intercept along the survey cord.
- Find your first "point intercept" (Pnt), the mark closest to your beginning stake. At this and each "point intercept" along the cord, gently drop the dowel rod until it touches the ground. Record each individual plant (exact plant identification is not necessary) that touches the dowel rod on a separate line on the "Plot Measurement" worksheet. Count each plant only once, even if the dowel rod touches the same plant more then once. Don't forget to include branches touching their dowel rod from nearby shrubs or sapling trees. Also include sticks and branches lying on the ground if they touch the dowel rod.
- If the dowel rod fails to touch any vegetation at this point, record the substrate (bare soil, rock, forest litter, etc.) in the species column. Bare soil and rocks will have a "0" diameter. Using your ruler, measure the depth of forest litter. Put that information under the diameter column. If the dowel rod hits several types of substrate, record only that which the pole hits first (i.e., if leaves cover a rock, only record the depth of the leaves).
- As an example: If you are in an open field working at your second intersect point and your dowel rod touches the side of a log, two different plants of grass, a tulip, and 2" of leaf litter on the ground, the worksheet would look like the table below:
- On their "Plot Measurement" worksheet, instruct the

Species or substrate type	Diameter of Stem or Blade of Grass					Vegetation		Heat Potential	
	0”	Under ¼ “	¼” – 1”	1” – 3”	Over 3”	*Dead*	*Living*	*Sun*	*Shade*
Grass		X					X	X	
Grass		X					X	X	
Flower			X				X	X	
Log					X	X		X	
Leaf Litter				X		X		X	

children to first indicate which point intersect they are working at, then list each species of plant that touches their dowel rod on a separate line. NOTE: Younger students need only writing down "grass", "flower", "shrub", "log", or "tree". Older students could use an appropriate field guide for more specific species identification.

- Next, students should measure the diameter or width of the stem, branch, trunk, or log that touches their dowel rod. Do this for each different plant that is located at this sampling spot.
- Under the "vegetation" column, indicate whether the plant is living or dead.
- Finally, check the appropriate heat potential column to indicate whether your sampling spot is in an open field (in the sun) or is located under a canopy of trees (in the shade).

Outdoors:

6. Move the class outside to the survey cord. Position each pairing at the appropriate starting point along the marked cord. Caution the students not to trample the vegetation close to the cord. Have the students begin working.

7. After all data has been collected, have the students group their data by size. For each point intersect, students should count the number of plants that can be found in each of the five size categories: (1) those that are 0" in diameter (rocks and bare soil); (2) those that are under ¼" diameter; (3) ¼"-1" diameter; (4) 1"-3" diameter; and (5) those over 3" in diameter.

8. Students may now graph their data by plants located at each intersect point. Using a long sheet of newsprint or other appropriate paper, draw a graph that has 36 points along the horizontal (X) axis. This will represent the 36 "point intercept" sampling points at which the students were working. [Note: you may have more or fewer intercept points depending upon the size of your class. To determine the number of points along the horizontal (X) axis, multiply the number of pairs of students times their 3 intercept points to get the total required graphing points. A class of 24 students would graph 36 points (12 pairs of students times 3 intercept points = 36 graphing points)]. The graph should be marked in consecutive whole numbers along the vertical (Y) axis. This will represent the total number of plants in each size grouping. Each pair of students should come in turn to mark the total number of plants within each size category that they found at each intersect point. The total number of small diameter plants (under ¼") found at intersect point #1 will be marked with a red marker above the #1 spot along the horizontal axis. The total number of medium diameter plants (¼"-1") found at intersect point #1 will be marked in green above the #1 spot along the horizontal axis. The total number of large diameter plants (1"-3") will be marked in blue, and the total number of very large diameter plants (over 3") will be marked in yellow above the #1 spot along the horizontal axis. Bare soil and/or rock substrate should be shown in black. Continue in this way for each intersect point along the graph until all groups have had a chance to plot their data.

9. Using the red marker, connect all red dots along the length of the graph. Repeat with the green, blue, and yellow markers. Connect the black dots only if they are located at adjacent intersect points.

10. Review with the class the fire potential of their sample plot. Did their sampling area have more small fuels that were 0"-¼" in diameter, or more large fuels that were 1"-3" in diameter?

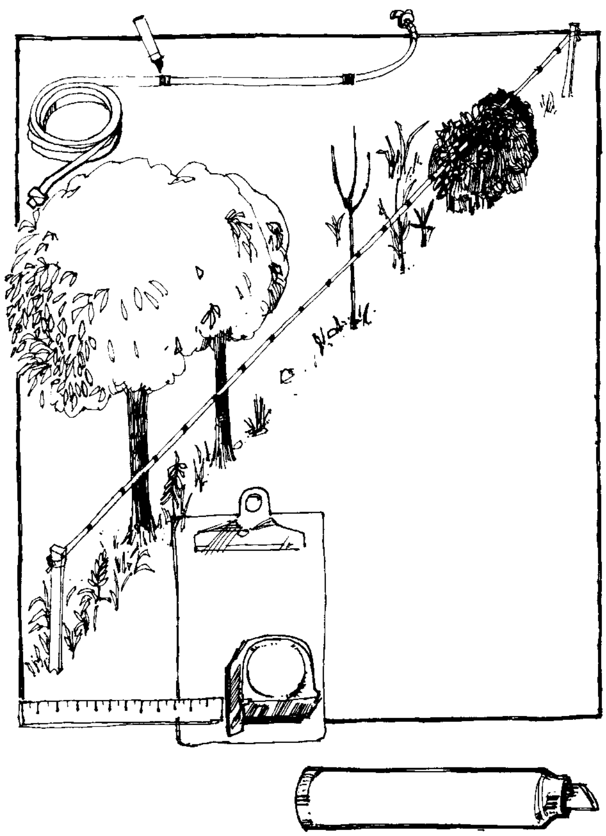
11. Using the information that the students know about ignition possibilities, what is the likelihood of a fire in this sample plot immediately after a rainstorm? What is the likelihood of a fire if there has been no rain for one month? Are there more living or dead materials in their plot? Will that change the fire-potential of the area? When you look at the graph, which spot along the graph is most likely to catch on fire first? Why?

ALTERNATIVES:

- For very young students, have each pair of students sample only one intersect point. Mark the "intersect points" at four-foot intervals along the cord.
- Older students could use an appropriate field guide for plant identification. Plants that can not be identified in the field may be collected for later identification in the classroom.

CLOSURE: There are many pieces of data that must be considered in predicting fire potential. Sometimes this can seem confusing and/or overwhelming. By using a sampling system, it is easier to look at all the variables. Scientists use random sample plots to make their predictions. Would you be interested in a career in fire prediction?

EVALUATION:
Outdoors, teachers will be able to evaluate students' ability to follow directions, to work cooperatively, and to remain on task. In the classroom students can be evaluated through their worksheets, their ability to graph results, and their participation in class discussions.



EXTENSIONS:

1. Review your sampling data a second time. What was the total number of living vs. dead vegetation at each sampling point? What percentage of your vegetation was located in the sun vs. plants located in the shade? Graph your data. Compare these graph results with your initial vegetation study. Is there a way to show all your data on one chart or graph? Would this new data change your fire prediction?

2. What other graphing methods might you be able to use with this data?

3. Choose a second sampling site that might contain a different variety of vegetation. Sample this second area. Compare results.

4. Allow younger students to collect a leaf, stem, or piece of wood at each intersect point. Have them group their collected vegetation into various categories. How many ways can these samples be grouped? Allow students to decide and graph their results. How many plants are in each category? Which category size is most abundant in their sample plot? Now take a second look at your collection. What other characteristics can you find among the vegetation samples? Do you notice a variety of leaf shapes, colors, textures, strengths (soft leaves, hard bark), etc. What other ways might lend itself to grouping your samples? Some possibilities may include groupings by leaf shape; types of flowers (including plants with no flowers); color of flower or leaf; size of stem; etc. Can you devise ways to graph these new results?

PLOT MONITORING

PLOT MEASUREMENT WORKSHEET

POINT #_______ Names:____

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Species or substrate type	Diameter or Width of Stem or Blade					Vegetation		Heat Potential	
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